Shared Information and Virtual Surfaces

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COLLABORATION AND KNOWLEDGE MANAGEMENT (CKM) PROGRAM

STRUCTURAL MODEL OF TEAM COLLABORATION
(MACRO-COGNITIVE PROCESS FOCUS)

Problem Area Characteristics

Collaborative Situation Parameters:

- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
- human-agent interface complexity

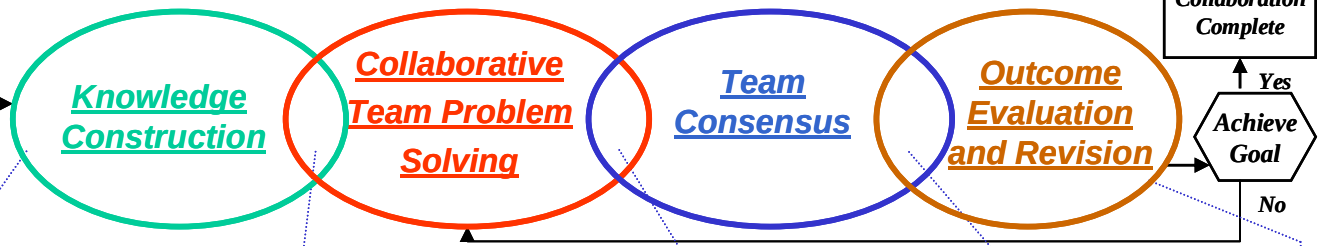
Team Types

- asynchronous
- distributed
- culturally diverse
- heterogeneous knowledge
- unique roles
- command structure (hierarchical vs. flat)
- rotating team members

Operational Tasks

- team decision making, COA selection
- develop shared understanding
- intelligence analysis (team data processing)

Collaboration Stages & Cognitive Processes

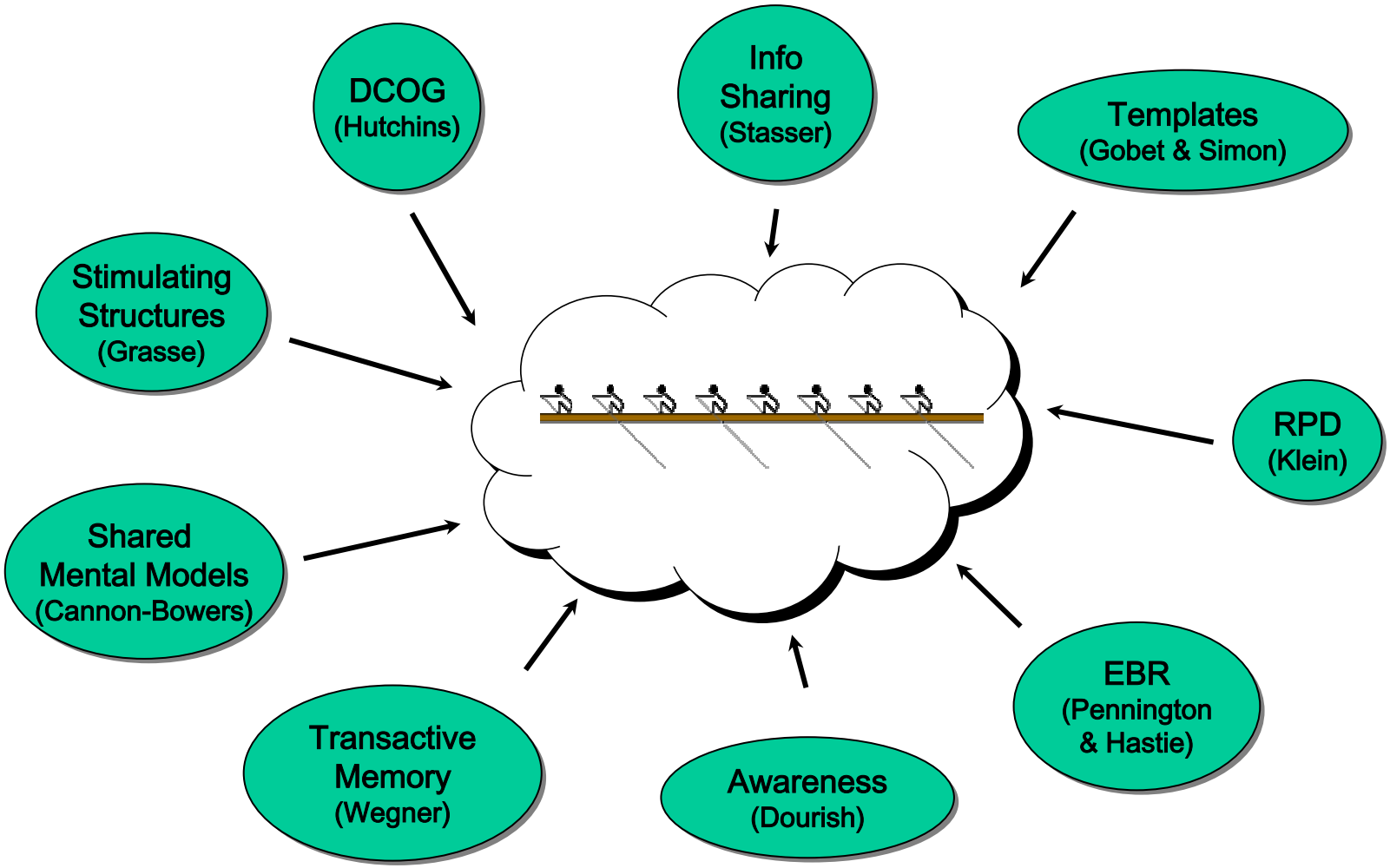


Meta-Cognitive:			
• individual conversion of data to knowledge	• team integration of individual knowledge for common understanding	• team agreement on a common solution	• solution adjustment to fit goals and exit criteria
Macro-Cognitive:			
• individual mental model construction • knowledge interoperability development • individual task, team and domain knowledge development • individual knowledge object development • individual visualization and representation of meaning	• knowledge interoperability development • iterative information collection and analysis • team shared understanding development • develop, rationalize, & visualize solution alternatives • convergence of individual mental models to team mental model • individual task, team and domain knowledge development • developing new knowledge • team agreement on situation	• team negotiation of solution alternatives • team pattern recognition • team shared understanding development • convergence of individual mental models • critical thinking • sharing hidden knowledge • individual task knowledge development • team task knowledge development	• compare problem solution against goals • team shared understanding development • convergence of individual mental models of solution • analyze, revise output

Mechanisms for achieving Meta, Macro, and Micro-Cognitive Processes (applies to all stages)

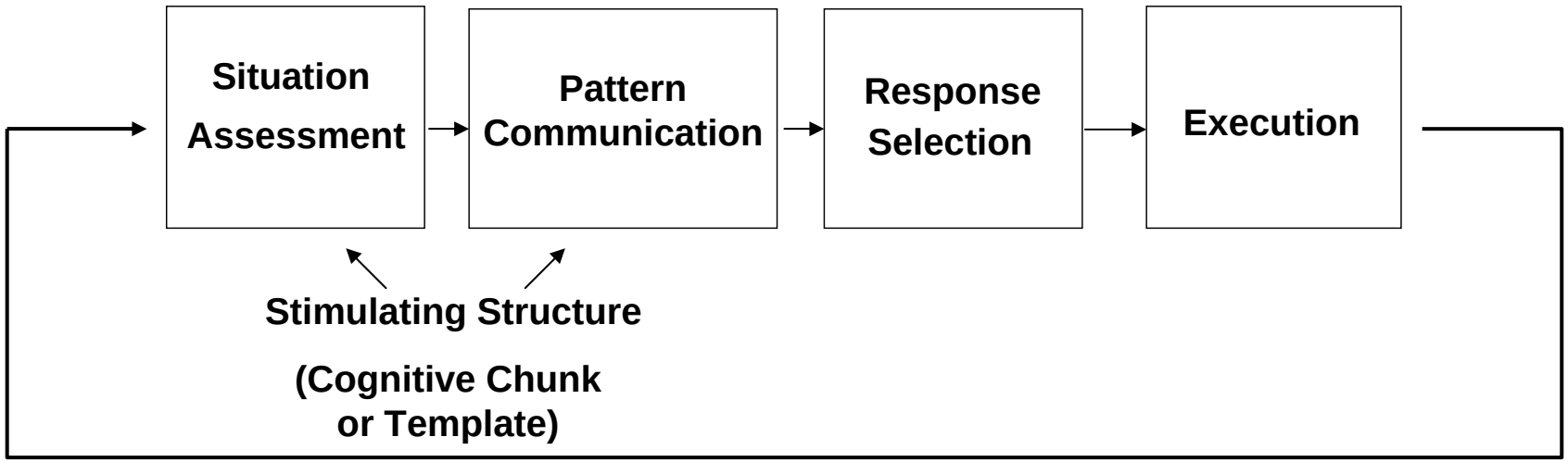
- **Verbal communications:** presenting and discussing individual information, discussing team generated information. questioning, agreeing / disagreeing, negotiating perspectives, discussing possible solutions, providing rationale.
- **Non-Verbal communications:** facial expressions, voice clues (vocal paralanguage), hand gestures, body movements (kinesics), touch (haptics), personal space, drawing, text messages, augmented video, affordances (cognition in objects).

Collaboration and Cognition



Collaboration and Cognition

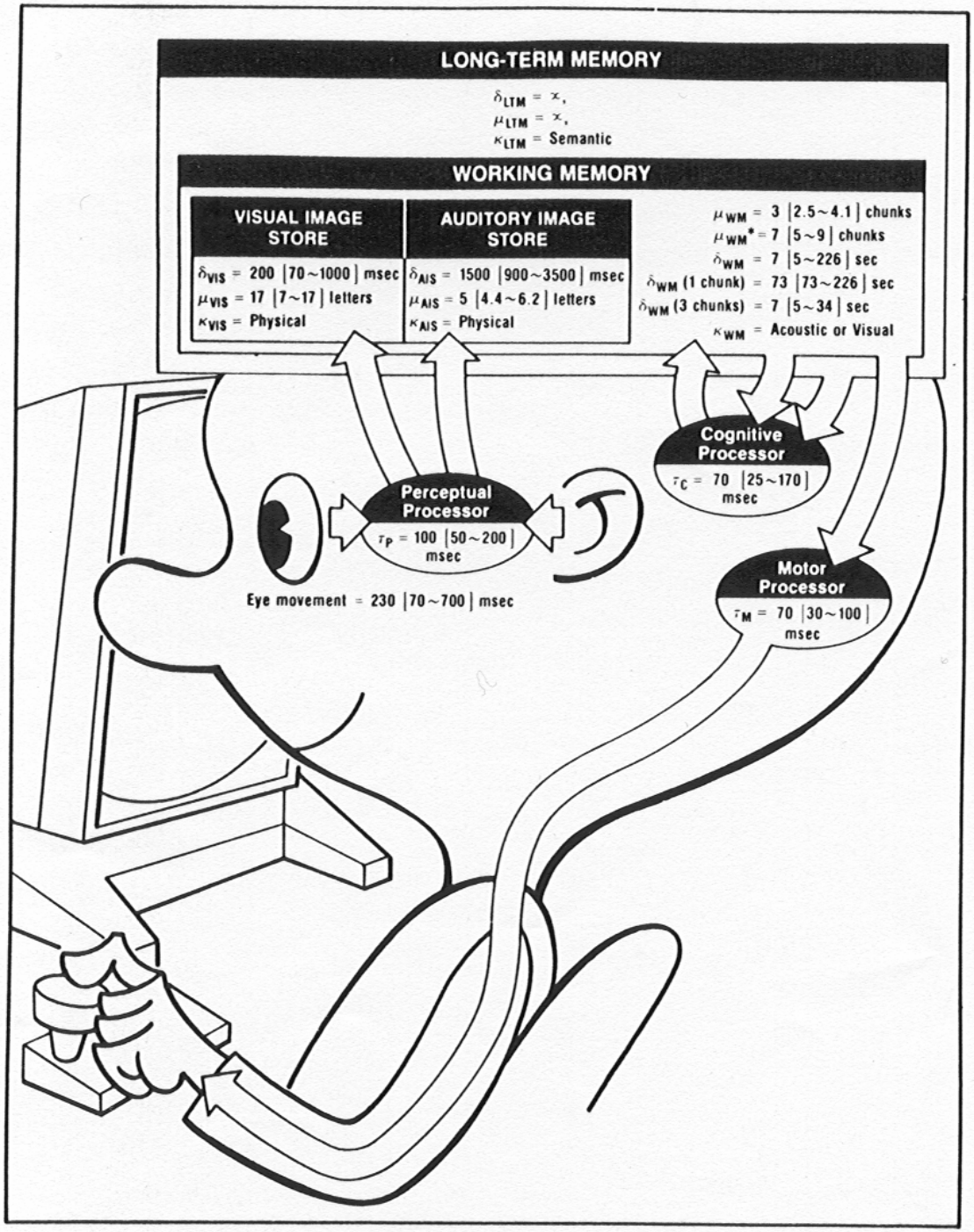
Team Recognition Primed Decision Making



- Knowledge is not action.
- Knowledge is situational.
- Action is in the situation. (Peter Keen)

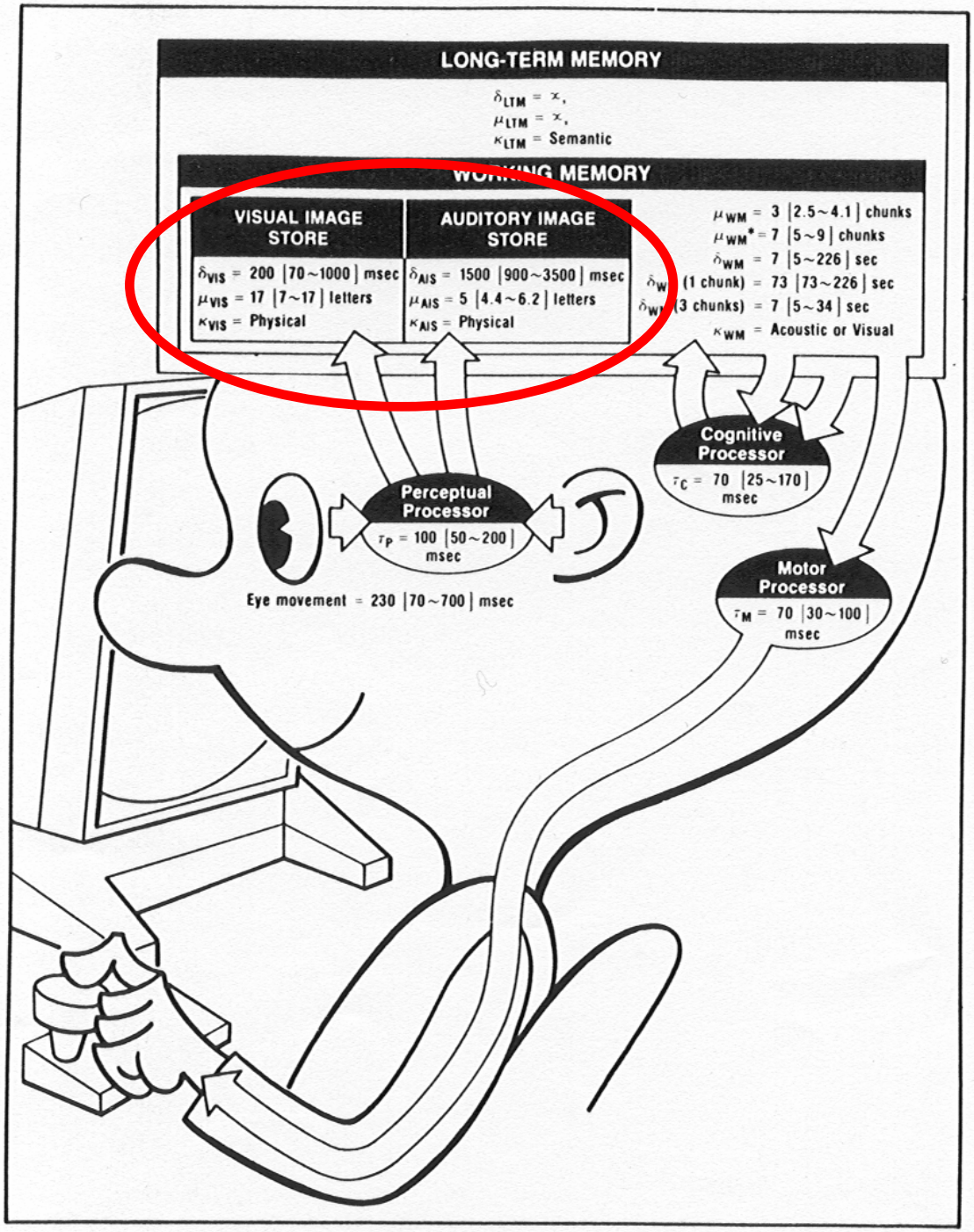
The Model Human Processor

(from Card, Moran, and Newell)



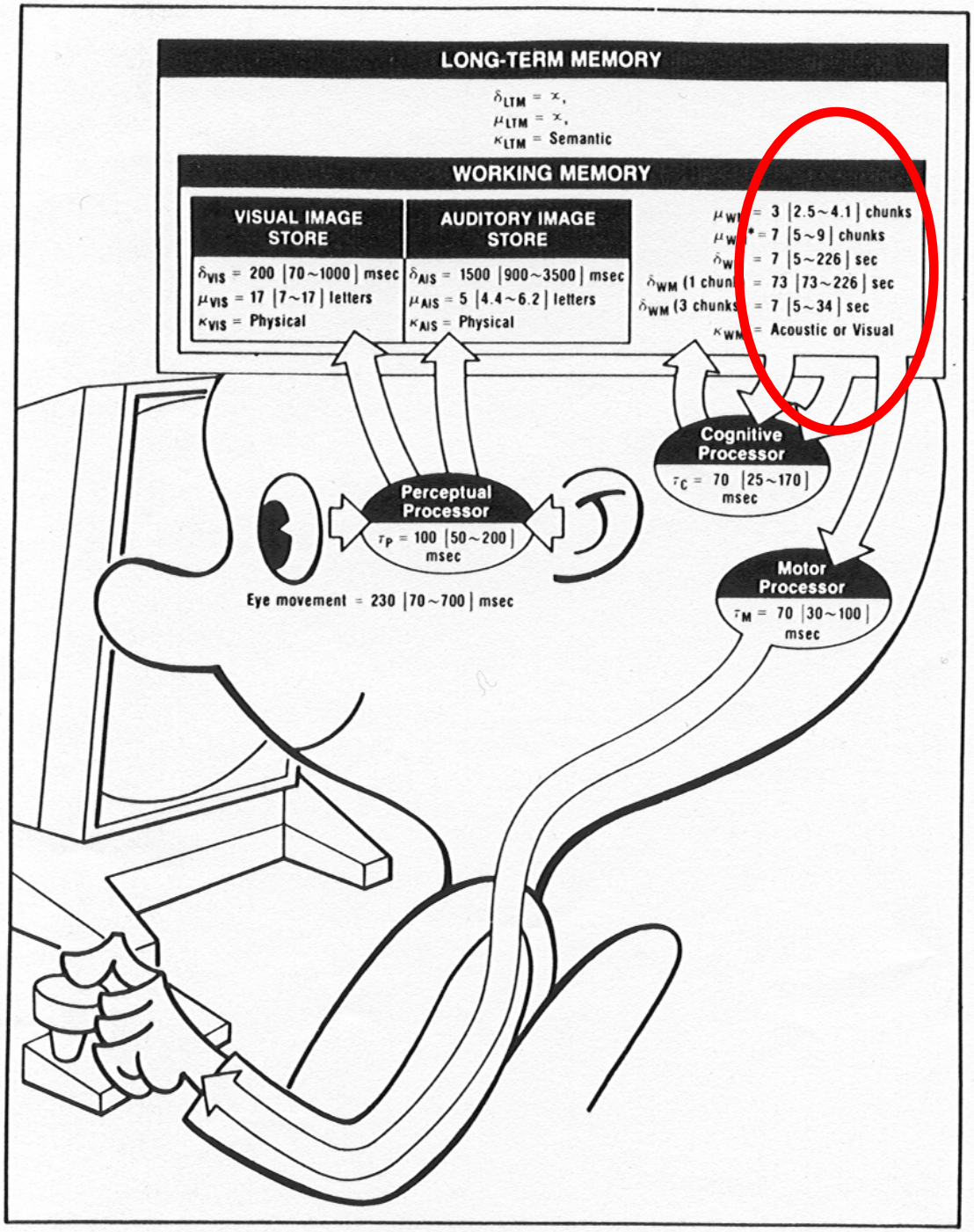
Multiple Independent Channels of Working Memory

(Baddeley)



Memory Chunks

(Simon, etc.)



Template Theory

- Recent refinement of memory chunks (Gobet and Simon, 1996, 1998, 2000)
- Experienced people create complex structures called “templates”
- Templates have a *core*, *slots* and *linkages* to other templates which facilitate **fast** access to long term memory
- Templates can store at least 10 items and are often labeled

Chess Template

a)

Template-core:

White ♙c4, ♙d5, ♙e4, ♙f2, ♙g2, ♔g1, ♘c3, ♗e2

Black ♟c7, ♟d6, ♟e5, ♟f7, ♟g6, ♟h7, ♚g8, ♗c8, ♞f6, ♗g7

Slot for pieces:

♙ : h2, h3

♟ : a7, a5

♞ : b8, d7, c5

♖ : f8, e8

♕ : c2, d1

♗ : c1, d2, e3

Slot for squares:

d2 : ♘, ♗, empty

e8 : ♖, ♞, empty

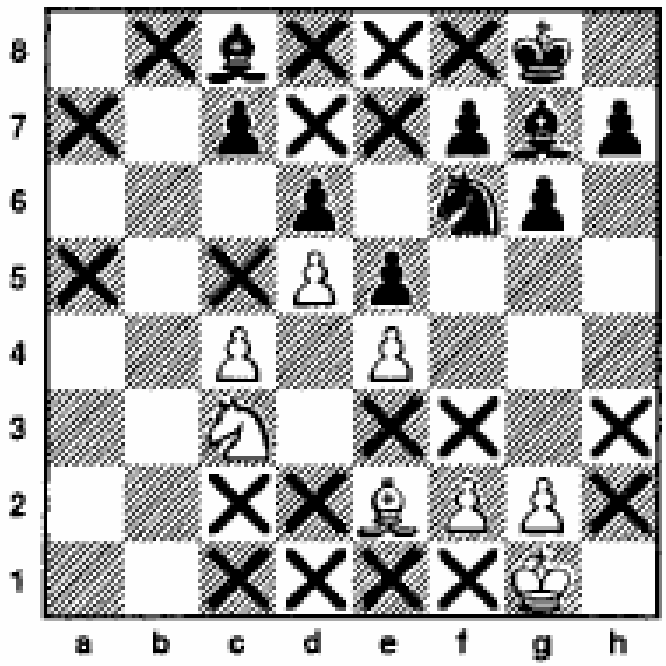
e1 : ♖, ♘, empty

Slot for opening: King's Indian Defense

Slot for plans: Break in the center with f7-f5

Slot for moves: 1... Nf6-e8
1... Nf6-h5

Links to other templates: chunk #231



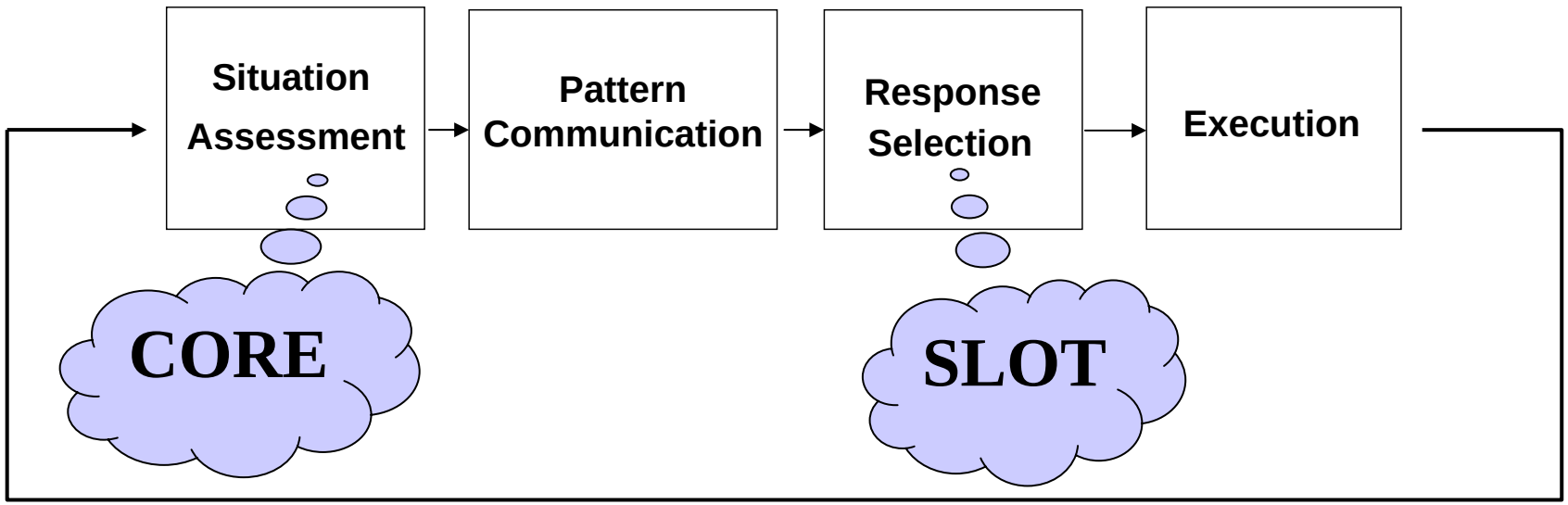
Template Creation

- Goal Oriented: a deliberate, conscious process
- Perceptual: a continuous, automatic process
- Perceptual dominates in many areas, i.e. verbal learning, chess expertise and problem solving.

Template Theory

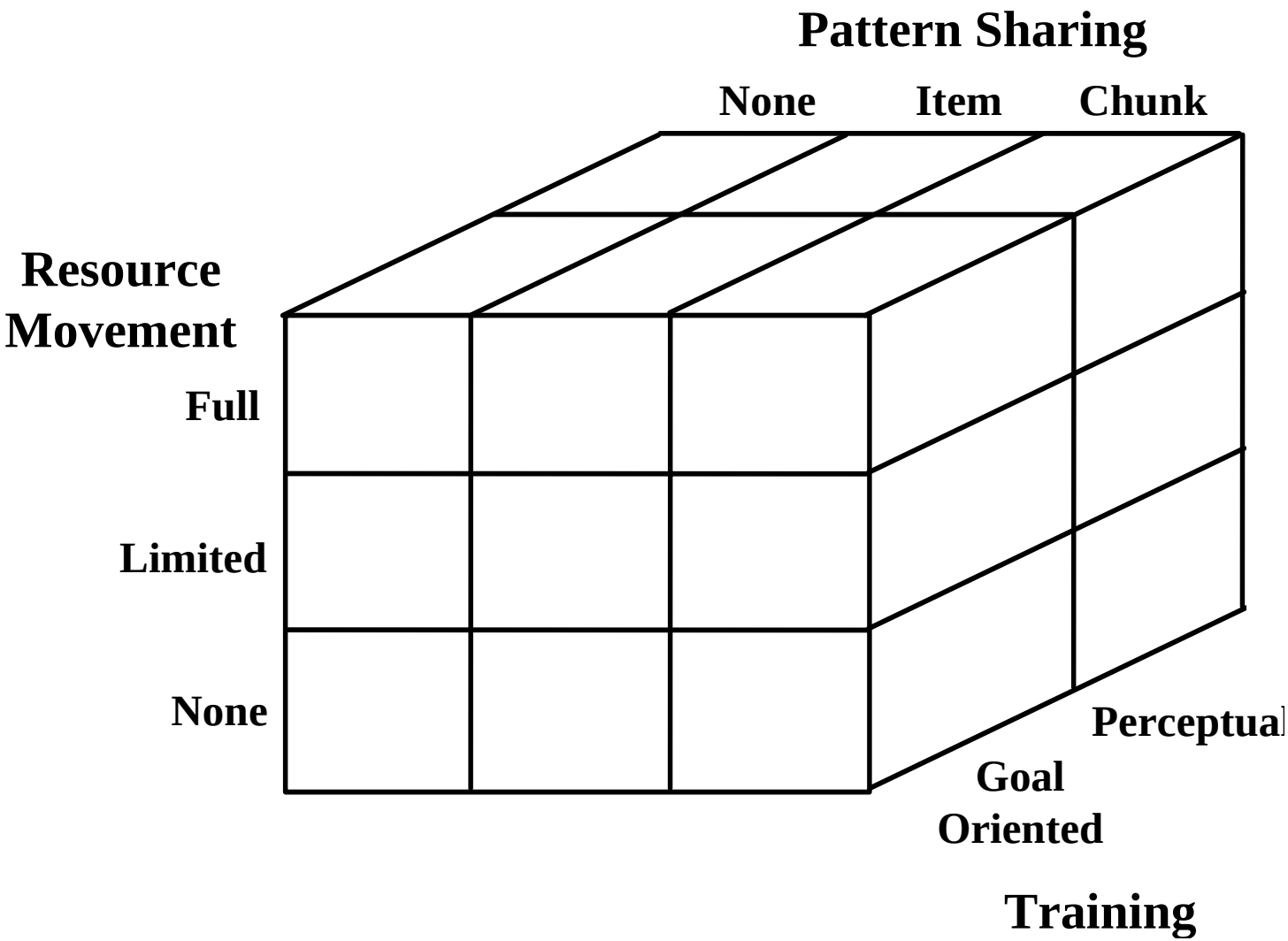
- **Core** Items
  - Used to Discriminate and Retrieve from Long Term Memory
  - Pattern Recognition
- **Slot** Items
  - Represent Context
  - Diagnostic
  - Response Selection

Collaboration and Cognition



Team Recognition Primed Decision Making

Experimental Design



FY '04 Progress

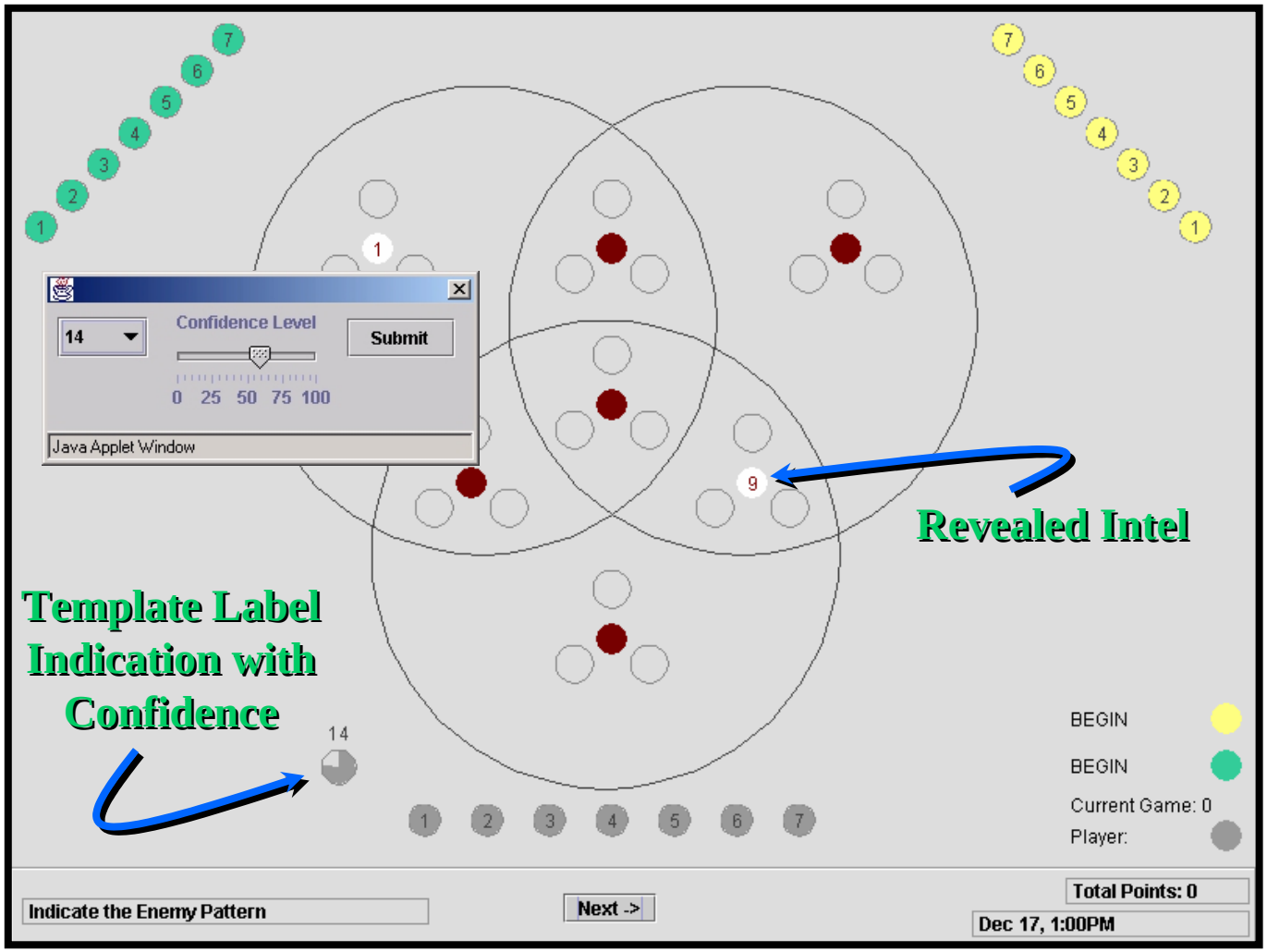
- Training Cells:
  - Item Training and Chunk Tool (7 groups)
  - Chunk Training and Item Tool (6 groups)
- Pilot – Expertise Process (6 groups)
- Pilot – chat/geographic anchor with NEO (8 groups)

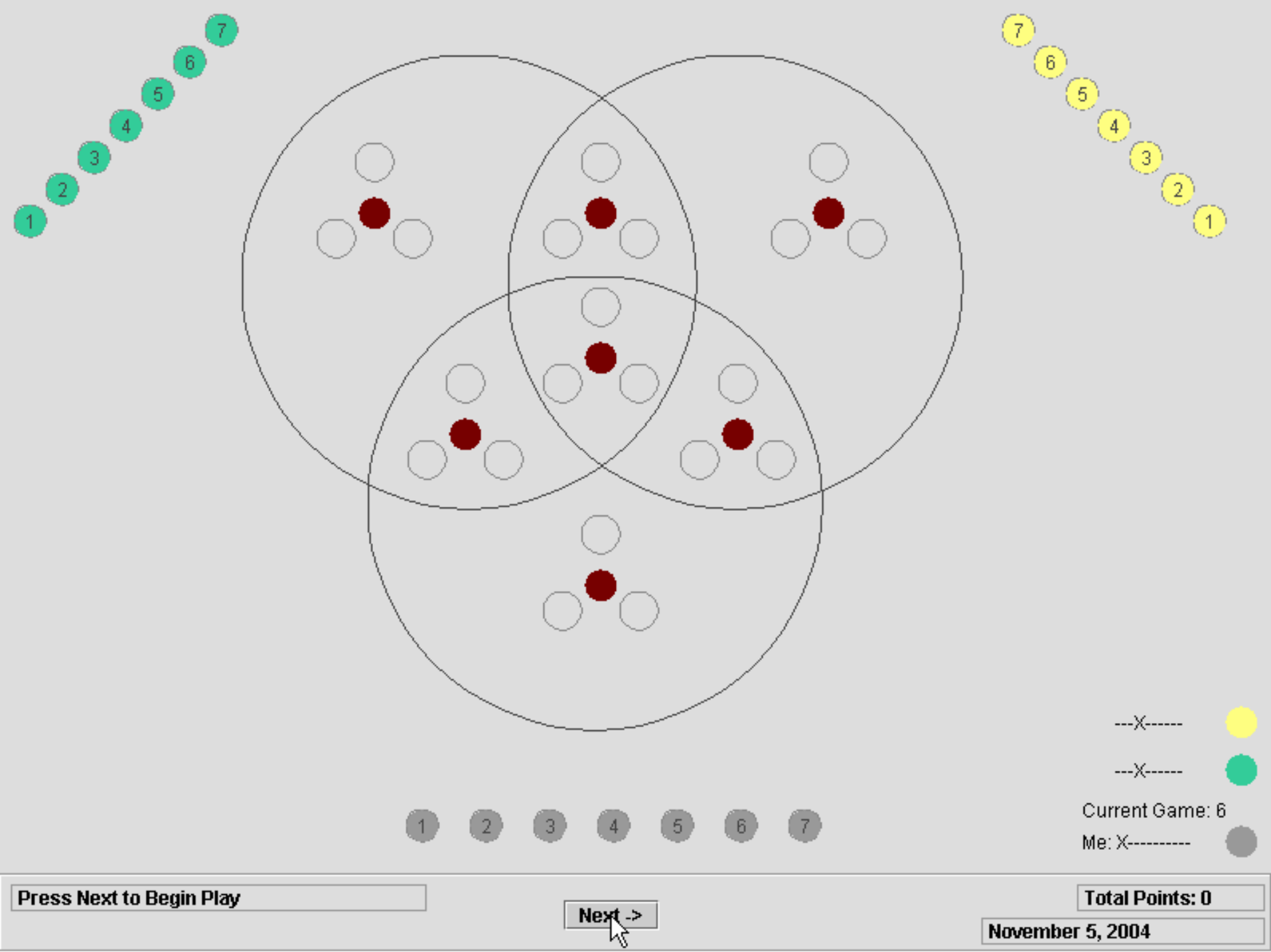
- **IEEE Transactions on Professional Communication**
  - last year's results conditionally accepted with minor revisions
- **International Journal of e-Collaboration (in press)**
- DSS'04 Conference (fast track to DSS Journal)
- HICSS Conference (last week)

Decision Game

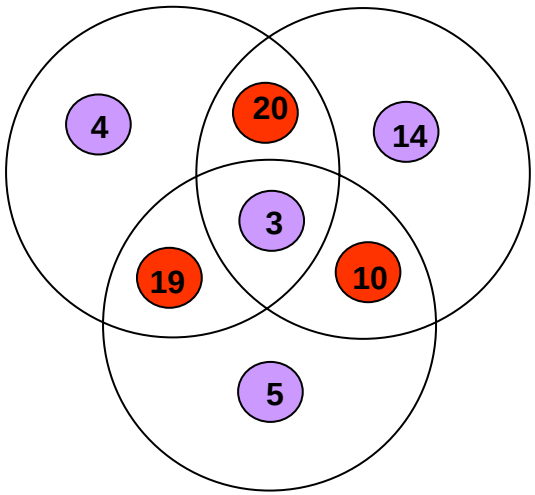
- Cooperative 3-Player Game
- Each player has 7 Tokens (numbered 1-7)
- Opponent has asymmetric force
  - Patterns: Definitive, Equivocal, Uncertain
- Team places tokens so total >= opponent
- Incentive
  - For total points
  - For time of play
- Play is interactive

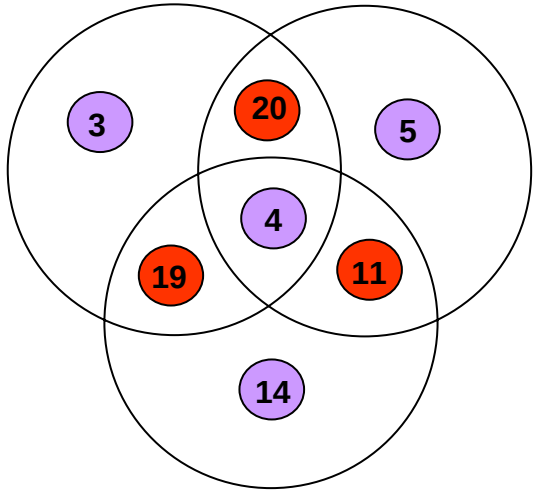
Experimental Task

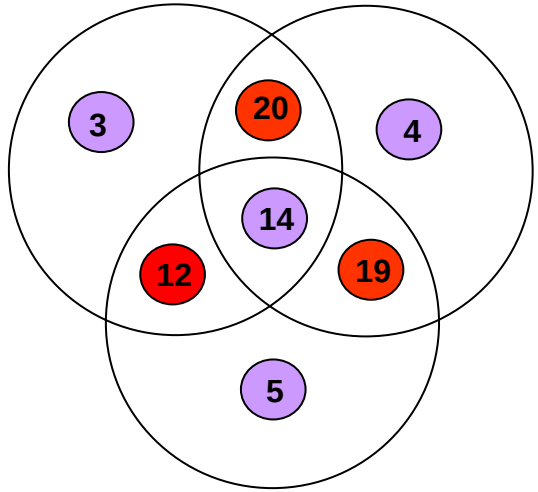



7
6
5
4
3
2
1
7
6
5
4
3
2
1
1
2
3
4
5
6
7
---X------
---X------
Current Game: 6
Me: X----------
Press Next to Begin Play
Next ->
Total Points: 0
November 5, 2004

Our Patterns as Templates







Chunk Labels

10 **11** **12**

● Core ● Slot

Experimental Setting

Hypotheses

- **Team members will play their tokens in a core region prior to playing tokens in a slot region.**
- **Team members will bump each others' tokens more in a slot region than in a core region when under uncertainty.**
- **Teams trained with goal-oriented chunking processes will outperform teams trained with automatic chunking processes.**

Definitive Performance

Tool

Training	None	Item	Chunk
Item	6.00	6.26	6.86
Chunk	6.64	6.93	6.65

Equivocal Performance

		Tool		
		None	Item	Chunk
Training	Item	5.70	5.88	6.29
	Chunk	5.99	5.95	6.02

Sharing Count – Team Average

		Tool	
		Item	Chunk
Training	Item	197	35
	Chunk	229	59

Sharing Correctness - Equivocal

		Tool	
		Item	Chunk
Training	Item	0.32	0.34
	Chunk	0.35	0.33

Movement – Definitive

		Tool	
		Item	Chunk
Training	Item	114 (core) 177 (slot)	221 172
	Chunk	91 112	152 195

Measure: cumulative order (lower is earlier play)

Bumping (Core/Slot)

		Tool		
		Item	Chunk	
Training	Item	.20 (core) .43 (slot)	.27 .12	Definitive
	Chunk	.02 .06	.31 .68	
	Item	.23 .41	.22 .23	Equivocal
	Chunk	.04 .08	.43 .57	

Training

- Chunk sharing provides best performance when trained with item details (no uncertainty)

None	Item	Chunk
6.00	6.26	6.86

Training

- Chunk sharing provides best performance when trained with item details (uncertainty)

None	Item	Chunk
5.70	5.88	6.29

Training

- Sharing tool has no effect when trained with templates (uncertainty)

None	Item	Chunk
5.99	5.95	6.02

Training

- Difference in process with respect to core/slot data under uncertainty (chunk sharing)

Training		***Tool*** Item	***Tool*** Chunk
Item		.20 (core) .43 (slot)	.27 .12
Chunk		.02 .06	.31 .68
Item		.23 .41	.22 .23
Chunk		.04 .08	.43 .57

e.g., Core/Slot change in proportion

Cognitive Fit Summary

- **Team members will play their tokens in a core region prior to playing tokens in a slot region – partial support**
- **Team members will bump each others' tokens more in a slot region than in a core region under uncertainty – supported**
- **Teams trained with goal-oriented chunking processes will outperform teams trained with automatic chunking processes – partial support**

Expertise – Correct SA

	Definitive	Equivocal
Core	.855	.443
Slot	.551	.430

Expertise Pilot Study

- Situation Assessment (Definitive Patterns)
  - Best Team (94%, 36%, 48%)
  - Worst Team (76%, 45%, 55%)
  - 2nd Best Team (86%, 89%, 61%)
- Situation Assessment (Uncertain Patterns)
  - Best Team (73%, 26%, 28%)
  - Worst Team (48%, 40%, 46%)
  - 2nd Best Team (64%, 25%, 32%)
- Best team has one exceptional player
  - Worst team has 3 mediocre players
  - 2nd best team has one good player

Expertise and Process (Bumps)

		Definitive	Uncertain
Best	1:	5 (20%)	42 (59%)
	2:	1 (100%)	22 (36%)
	3:	3 (66%)	29 (45%)
Worst	1:	0 (0%)	4 (25%)
	2:	0 (0%)	2 (100%)
	3:	0 (0%)	1 (0%)
2nd Best	1:	2 (0%)	9 (67%)
	2:	1 (0%)	4 (75%)
	3:	2 (0%)	10 (26%)

Expertise and Process (Bumps)

		Definitive	Uncertain
Best	1:	5 (20%)	42 (59%)
	2:	1 (100%)	22 (36%)
	3:	3 (66%)	29 (45%)
Worst	1:	0 (0%)	4 (25%)
	2:	0 (0%)	2 (100%)
	3:	0 (0%)	1 (0%)
2nd Best	1:	2 (0%)	9 (67%)
	2:	1 (0%)	4 (75%)
	3:	2 (0%)	10 (26%)

More bumping under uncertainty

Expertise and Process (Bumps)

		Definitive	Uncertain
Best	1:	5 (20%)	42 (59%)
	2:	1 (100%)	22 (36%)
	3:	3 (66%)	29 (45%)
Worst	1:	0 (0%)	4 (25%)
	2:	0 (0%)	2 (100%)
	3:	0 (0%)	1 (0%)
2nd Best	1:	2 (0%)	9 (67%)
	2:	1 (0%)	4 (75%)
	3:	2 (0%)	10 (26%)

Best Team Bumps Most

Expertise and Process (Bumps)

		Definitive	Uncertain
Best	1:	5 (20%)	42 (59%)
	2:	1 (100%)	22 (36%)
	3:	3 (66%)	29 (45%)
Worst	1:	0 (0%)	4 (25%)
	2:	0 (0%)	2 (100%)
	3:	0 (0%)	1 (0%)
2nd Best	1:	2 (0%)	9 (67%)
	2:	1 (0%)	4 (75%)
	3:	2 (0%)	10 (26%)

Best Player Bumps Most of ALL

Expertise, Process and Core/Slot

All Patterns

Best	1:	50 (24c, 26s)
	2:	20 (5c, 15s)
	3:	32 (15c, 17s)
Worst	1:	4 (4c, 0s)
	2:	2 (2c, 0s)
	3:	1 (0c, 1s)
2nd Best	1:	11 (5c, 6s)
	2:	5 (3c, 2s)
	3:	21 (18c, 3s)

Expertise, Process and Core/Slot

	All Patterns	Uncertain
Best	50 (24c, 26s)	45 (24c, 21s)
	20 (5c, 15s)	19 (14c, 5s)
	32 (15c, 17s)	29 (13c, 16s)
Worst	4 (4c, 0s)	4 (4c, 0s)
	2 (2c, 0s)	2 (2c, 0s)
	1 (0c, 1s)	1 (0c, 1s)
2nd Best	11 (5c, 6s)	9 (5c, 3s)
	5 (3c, 2s)	4 (3c, 1s)
	21 (18c, 3s)	19 (17c, 2s)

Best Players Never Bumped on CORE data in Definitive Condition

Training Study

- Difference in process with respect to core/slot data under uncertainty (chunk sharing)

		Tool		
		Item	Chunk	
Training	Item	.20 (core) .43 (slot)	.27 .12	Definitive
	Chunk	.02 .06	.31 .68	
	Item	.23 .41	.22 .23	Equivocal
	Chunk	.04 .08	.43 .57	

Findings

- Best players exhibit interaction between uncertainty and core/slot
  - Definitive: bump slot data exclusively
  - Uncertainty: bump core/slot data equally

Chat Tool Pilot Study

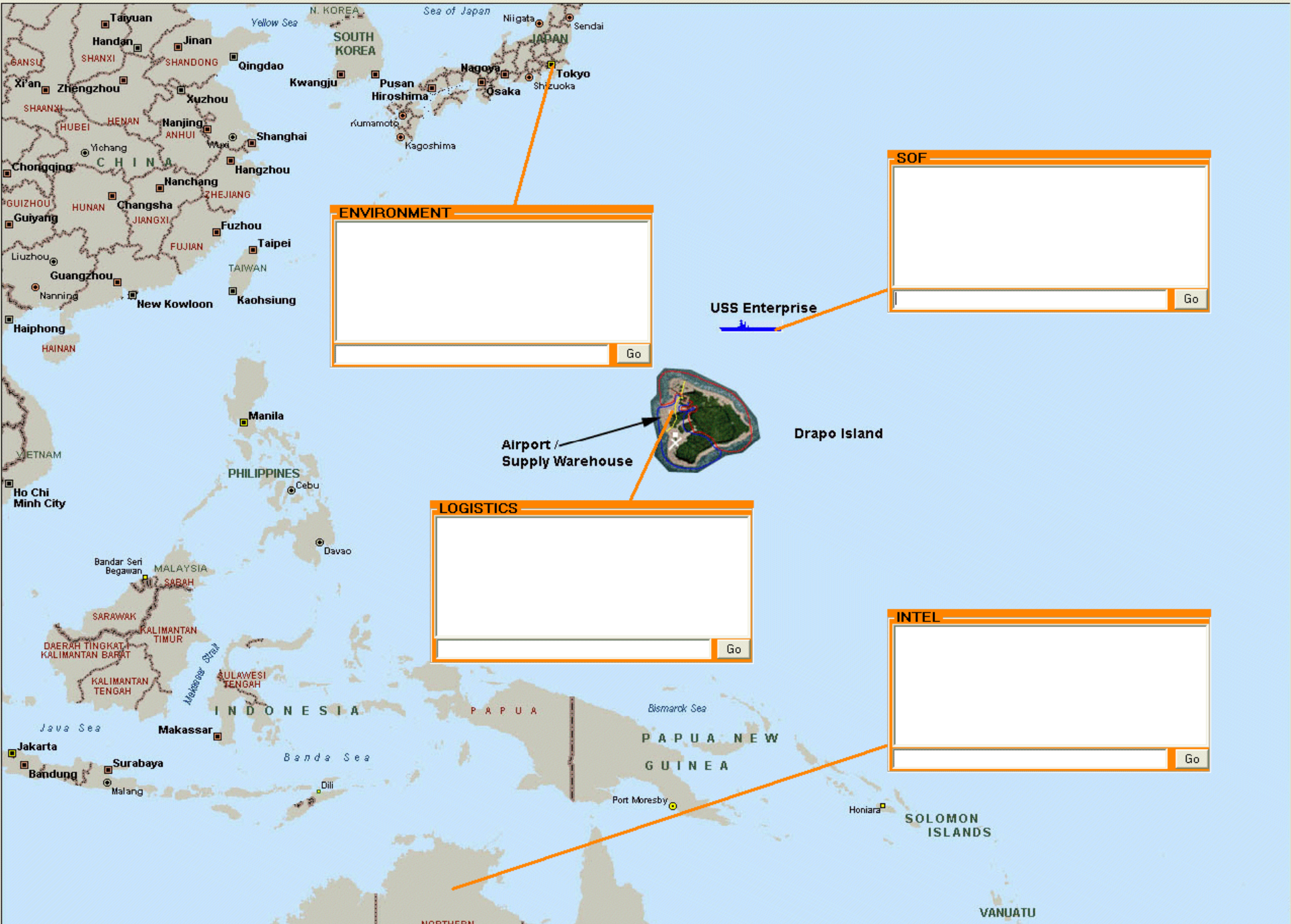
- Research Question:
  - How does template theory apply to typical chat interactions?
    - Cueing templates through geographic anchoring?
    - Cueing templates through transactive memory, i.e. personal identifiers (window labels)?
  - How are core and slot data shared in this context?
- NEO Scenario

STTR DEMO

File

STTR DEMO

File



NEO Observations

- Difficult task for non-military participants
  - Much knowledge is assumed, e.g. C-130 landing on an aircraft carrier.
- Discussion converges to single chat window
  - Reflects good decision process
- Repeated Theme:
  - "I want a place for me, and a place to share"
  - Suggests template cueing strategy based on personal identity

Transitions to Navy Tasks

- Principles
  - Train using goal-orientation (templates)
  - Provide “chunk” Pattern-Sharing Tool for SA
  - Provide tool in Action Tasks for manipulating “slot” data
  - Transform Effortful Cognitive Tasks into Simple Perceptual Tasks

FY 2005 Plans and Onward

- Template Theory and Context
  - Core data critical during Situation Assessment
  - Slot data critical during Response Selection
- Template Theory and Uncertainty
  - Core data shared when less uncertainty
  - Slot data shared when more uncertainty

FY 2005 Plans and Onward

- Dynamic Creation of Templates
  - Goal Orientation vs. Perceptual
  - Cognitive Centrality (knowledge overlap)

- Algorithm Development
  - Detection of cognitive mis-alignment
  - Metrics for measuring same

Questions?